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SYNTHESIS OF NEW PHOSPHORS BASED ON Tm^{3+}, Nd^{3+} OR Ho^{3+} DOPED GERMANATES BY "WET" CHEMICAL ROUTES

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Abstract. Various "wet" synthetic chemical techniques are widely used for the production of multifunctional inorganic materials. In contrast to the standard high-temperature solid state route, methods based on the dissolution of starting reagents allow one to obtain phases with given particle morphology and particle size distribution. Besides, with this approach, the defect structure can be efficiently controlled by varying the synthesis conditions and solution preparation. These advantages are important for producing luminescent materials.

New series of $Sr_3RE_2(Ge_3O_9)_2$ (*RE* – rare earth) cyclogermanates, $ALa_9(GeO_4)_6O_2$ (*A* – alkali metal) apatites, $NaYGeO_4$ olivines and Tm^{3+}, Nd^{3+} or Ho^{3+} doped solid solutions based on these compounds have been synthesized by citrate method and ultrasonic spray pyrolysis [1–3]. Nowadays, germanates are considered as efficient optical hosts for phosphor design with emission in the visible and infrared spectral ranges and can be applied in solid-state lighting and display industry.

For synthesis, RE_2O_3, GeO_2 and $A_2CO_3/SrCO_3$ were taken as initial reagents. RE_2O_3 and $A_2CO_3/SrCO_3$ were dissolved in a nitric acid aqueous solution, and GeO_2 – in an ammonium hydroxide aqueous solution. The acid and alkaline solutions were mixed. In case of citrate method, citric acid was added to the precursor solution and the solution was evaporated. The solid residue was decomposed and annealed in air at 1000–1100ºC. In the spray pyrolysis procedure, the precursor solution was changed into aerosol, which was directed through a hot pyrolysis furnace with air used as a carrier gas. When the aerosol passed through the reactor, intraparticle reactions occurred. The synthesis temperature in the reactor was 990ºC.

The EPR method showed that disequlibrium $ALa_9(GeO_4)_6O_2$ samples obtained by spray pyrolysis are defective in the germanate $[GeO_4]^{4-}$ sublattice. The influence of intrinsic defects on the optical properties of $ALa_9(GeO_4)_6O_2$ apatites was studied by the optical absorption and pulsed cathodoluminescence methods [2]. The luminescence spectra (λ_{ex} = 356 nm) of Tm^{3+} doped apatites consist of a series of lines in the 430–850 nm wavelength region, the most intensive peak at 477 nm is caused by the $^1G_4 \rightarrow {}^3H_6$ transition in Tm^{3+}. The values of color purity (93%) and correlated color temperature (4270 K), which were determined for $NaLa_{8.9}Tm_{0.1}(GeO_4)_6O_2$, exhibiting the most intensive emission, allow us to consider this compound as a potential blue emitting phosphor [3].

References

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